J. Helminthol. Soc. Wash.
62(1), 1995, pp. 27–31

Nematode Fauna of the Two Sympatric Rats *Rattus rattus* and *R. exulans,* in Kao District, Halmahera Island, Indonesia

HIDEO HASEGAWA[1] AND SYAFRUDDIN[2]

[1] Department of Parasitology and Research Center of Comprehensive Medicine, Faculty of Medicine, University of the Ryukyus, Nishihara, Okinawa 903-01, Japan and
[2] Department of Parasitology, Faculty of Medicine, Hasanuddin University, Ujung Pandang, Indonesia

ABSTRACT: A comparison was made of the parasitic nematode fauna between 2 sympatric rats, *Rattus rattus* and *Rattus exulans,* in Kao District, Halmahera Island, Indonesia. A total of 29 *R. rattus* and 20 *R. exulans* were examined, and 11 nematode species were found in them. *Strongyloides venezuelensis* was recorded from *R. exulans* for the first time. A remarkable difference was observed in the prevalence of *Nippostrongylus brasiliensis,* which was quite common in *R. rattus,* whereas no adult worms were collected from *R. exulans.* It is suggested that *R. exulans* is less susceptible to *N. brasiliensis.* Some common rat parasites of the Pacific islands were not observed. This may reflect the small sample size or a depauperate fauna.

KEY WORDS: Nematode fauna, *Rattus* spp., Halmahera Island, Indonesia, zoogeography, ecology.

Halmahera Island belongs to the Molucca Islands of Indonesia and is located between Sulawesi and New Guinea (Fig. 1). Nothing has been reported on the parasitic helminth fauna of rats from this island. In July 1993, we had an opportunity to collect rats for parasitological examination in the Kao District, North Halmahera. This paper deals with a comparison of the nematode fauna between 2 sympatric rat species, *Rattus rattus* of the Asian variety (=*Rattus tanezumi* sensu Musser and Carleton, 1993) and *Rattus exulans,* the dispersal of which to the Pacific islands is believed to have occurred in association with human movements (see Musser and Carleton, 1993; Roberts, 1991).

Materials and Methods

Four localities, namely, Popon, Kao, Pediwan, and Kai, were chosen for study (Fig. 1). Kao and Popon are at less than 50 m elevation, whereas Pediwan and Kai are at about 100 m elevation. Rodents were captured by using wire-cage live traps and plastic snap traps, baited with raw cassava or baked coconuts. Trapping sites were among bushes in palm plantation fields in Kao and Popon and forest edges in Pediwan and Kai. Rats collected alive were euthanized by overdosing with chloroform. The lungs, alimentary canal, and liver were fixed in 10% formalin solution and then transported to the laboratory for parasite examination. The lung and liver were sliced and examined under a stereomicroscope. The alimentary canal was cut open, the mucosal surface was vigorously rubbed and washed on a sieve with an aperture size of 75 μm, and the residues on the sieve were examined under a stereomicroscope. The stomach and esophageal walls were observed under stereomicroscope with transmitted illumination for detection of nematodes under the mucosal lining. Nematodes were rinsed in 70% ethanol solution, cleared in a glycerol-alcohol solution, and mounted with 50% glycerol solution. Representative nematode specimens are deposited in the U.S. National Museum Helminthological Collection, Beltsville, Maryland, U.S.A., with the accession numbers USNM Helm. Coll. 84322–84338. Voucher host specimens have been deposited in the American Museum of Natural History, New York, U.S.A., with the accession numbers AMNH 267655–267680 and 267682–267703.

Results

A total of 29 *Rattus rattus* (snout–vent length 92–216 mm [$\bar{x}$ 174 ± 32 SD mm]) and 20 *Rattus exulans* (snout–vent length 90–150 [$\bar{x}$ 122 ± 17 SD mm]) were examined. Ten and 7 species of nematode parasites were collected from *R. rattus* and *R. exulans,* respectively (Table 1), all in the alimentary tract. No nematodes were detected in the lungs or livers.

In *R. rattus, Nippostrongylus brasiliensis* (Travassos, 1914) was the most prevalent nematode, being followed by *Strongyloides ratti* Sandground, 1925, and *Strongyloides venezuelensis* Brumpt, 1934. Concurrent infection with both *Strongyloides* species was observed in 14 (61%) of the 23 *R. rattus* in which any nematodes were detected. In 11 of the 12 rats infected with *Orientostrongylus tenorai* Durette-Desset, 1970, *N. brasiliensis* was also present. Counts of *N. brasiliensis* infections revealed that 55% of the infected *R. rattus* harbored less than 10 worms, and the rest harbored more than 60. One rat was found to be parasitized by 212 *N. brasiliensis.* In *O. tenorai* infections, more than 70% of *R. rattus* harbored less than 10 specimens. The individual with the maximum intensity of *N. brasiliensis*

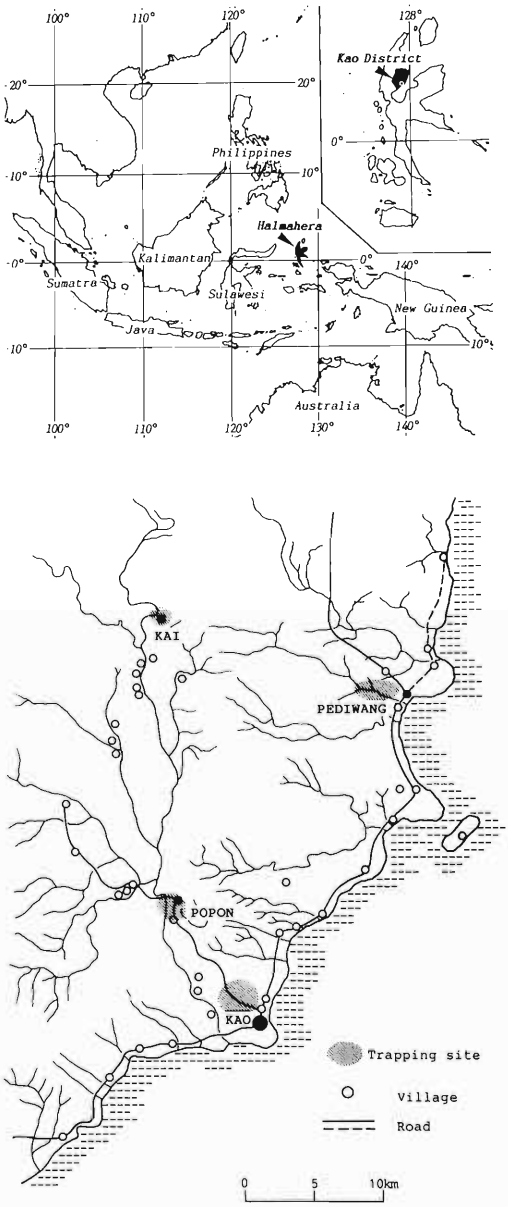

Figure 1. A map showing the survey area. Halmahera Island (above), Kao District (above right inset), and trapping sites (below).

infection also showed the highest intensity of *O. tenorai* infection, 280 worms. The worm burden profile of *Syphacia muris* (Yamaguti, 1935) showed that 9 of the 10 infected *R. rattus* were parasitized by less than 60 worms, but the remaining rat harbored ca. 1,800 individuals. The intensity of infection with adult spirurids, that is, *Gongylonema neoplasticum* (Fibiger and Ditlevsen, 1914) and *Pterygodermatites whartoni* (Tubangui, 1931), was less than 5 in all cases. One spirurid larva, probably *Mastophorus muris* (Gmelin, 1790), was also detected.

In *R. exulans,* the most prevalent nematode was *O. tenorai,* and its prevalence was more than twice that in *R. rattus.* However, *O. tenorai* from *R. exulans* was generally smaller (males 1.39–1.65 mm long by 48–64 μm wide, spicule length 67–74 μm; females 2.06–2.62 mm long by 51–64 μm wide) than that from *R. rattus* (males 1.63–2.09 mm long by 61–70 μm wide, spicule length 70–86 μm; females 2.53–3.31 mm long by 62–85 μm wide). As in *R. rattus,* the intensity of infection with *O. tenorai* was less than 10 in more than 70% of *R. exulans,* and the maximum worm burden was only 56. Adult *N. brasiliensis* was not observed in *R. exulans,* although a single fourth-stage male larva of *Nippostrongylus,* probably *N. brasiliensis,* was found in 1 rat. *Strongyloides venezuelensis* was also common in *R. exulans,* being detected in over 60% of them but *S. ratti* was less prevalent, and mixed infections of the 2 species were found only in 4 individuals (20%). The prevalence of *S. muris* was much higher than in *R. rattus* (Table 1). Eleven of 15 *R. exulans* (73%) with *S. muris* infection harbored less than 60 worms, and 2 harbored ca. 600 and 800 pinworms, respectively. Only 3 spirurid larvae, presumably *P. whartoni,* were detected in 1 *R. exulans.*

Three species belonging to the subfamily Capillariinae were collected from the small intestine: *Capillaria traverae* Ash, 1962 (1 complete male), and Capillariinae gen. sp. A (1 male and 1 female each lacking anterior portion) from *R. rattus* and Capillariinae gen. sp. B (1 female lacking anterior portion) from *R. exulans* (Table 1). The male of *C. traverae,* 4.79 mm long by 43 μm wide, was morphologically identical to the previous descriptions except that it had 2 pairs of caudal papillae, of which anterior 1 pair was quite minute and hardly discernible. Capillariinae gen. sp. A lacked lateral caudal alae, had a membraneous bursa supported by 1 pair of lobular projections, an indistinct spicule with a spinose sheath in a fragmented male that was 5.1 mm long excluding the esophageal portion, and its fragmented female had a postesophageal body of 4.0 mm long, no ornamentation at the vulva, and thick-shelled eggs of 48–50 by 18–22 μm in size. The female of Capillariinae gen. sp. B was 3.9 mm long in the postesophageal body by 45

Table 1. Prevalence of nematode parasites in *Rattus* spp. collected from Halmahera Island, Indonesia, July 1993.

	Host species							
	Rattus rattus				*Rattus exulans*			
Locality	Popon	Kao	Pediwan	Total	Popon	Kao	Kai	Total
No. hosts examined	9	19	1	29	3	16	1	20
Snout–vent length of hosts								
Range	112–195	92–216	214	92–216	111–126	90–150	127	90–150
$\bar{x} \pm$ SD (mm)	164 ± 28	177 ± 33		174 ± 32	119 ± 8	122 ± 19		122 ± 17
No. hosts with nematodes	3	19	1	23 (79%)	3	16	1	20 (100%)
Nematode species								
Capillaria traverae		1		1 (3%)*				
Capillariinae gen. sp. A		1		1 (3)				
Capillariinae gen. sp. B					1			1 (5)
Strongyloides ratti	1	14	1	16 (55)	1	3		4 (20)
Strongyloides venezuelensis	1	14	1	16 (55)	1	10	1	12 (60)
Syphacia muris		9	1	10 (34)	2	12	1	15 (75)
Nippostrongylus brasiliensis	2	17	1	20 (69)	1†			1 (5)
Orientostrongylus tenorai	2	10		12 (41)	3	15		18 (90)
Gongylonema neoplasticum		2		2 (7)				
Pterygodermatites whartoni	1	4		5 (17)	1†			1 (5)
Mastophorus muris		1†		1 (3)				

* No. hosts infected with prevalence in parentheses.
† Tentative identification due to larval stage of the worms.

μm wide, with a prominently protruded vulval flap, and the eggs were relatively thin-shelled and 51–54 by 22 μm in size.

Discussion

Strongyloides ratti, S. muris, N. brasiliensis, G. neoplasticum, P. whartoni, and *M. muris* have been recorded as common parasites of *R. rattus* of Southeast Asia, Taiwan, southern Japan, the Philippines, and some of the Pacific islands (see Hasegawa et al., 1993, 1994). In East Asia, *S. venezuelensis* was first recorded in *Rattus norvegicus* of Okinawa, southern Japan (Hasegawa et al., 1988), and was subsequently collected from *R. rattus* on Lanyu, Taiwan (Hasegawa et al., 1994). This species is readily distinguished from *S. ratti* by having spiraled ovaries in the parasitic female, but both species seem to have been hitherto confused because of their minute sizes and frequent concurrent infection (Hasegawa et al., 1988, 1994). The prevalence of *S. venezuelensis* in *R. exulans* was much higher than *S. ratti* (Table 1). Although *Strongyloides* worms hitherto recorded from *R. exulans* of Southeast Asia and Pacific islands have been identified as *S. ratti* (Sinniah, 1979; Uchikawa et al., 1984), a detailed reexamination may reveal wider distribution of *S. venezuelensis* in this rat.

Orientostrongylus tenorai belongs to the subfamily Nippostrongylinae (Trichostrongyloidea: Heligmonellidae) and has been recovered from various rats of Afghanistan, India, Southeast Asia, and Taiwan (Durette-Desset, 1970; Ohbayashi and Kamiya, 1980; Ow Yang et al., 1983; Hasegawa, 1990; Hasegawa et al., 1994). Only limited records have been made on nippostrongylines from *R. exulans*: Schacher and Cheong (1960) reported *N. brasiliensis* from Singapore and Kuala Lumpur (prevalence 0.8 and 1.2%, respectively); Sinniah (1979) found *Nippostrongylus* sp. from Peninsular Malaysia (prevalence 10.2%); Ow Yang et al. (1983) listed *O. tenorai* and *O. krishnansamy* Durette-Desset and Lim-Boo-Liat, 1974, from Malaysia (prevalence not given); and Uchikawa et al. (1984) collected Trichostrongyloidea gen. sp. from Fiji (14.3%). However, in these studies, except for Ow Yang et al. (1983), *Orientostrongylus* seemed to be not considered. Because, until recently, *O. tenorai* has often been confused with *N. brasiliensis* (see Hasegawa et al., 1994), it is highly probable that *O. tenorai* was mixed among the specimens registered as *Nippostrongylus* or Trichostrongyloidea gen. sp.

The most remarkable difference in the nematode fauna found between the 2 murine species was the prevalence of *N. brasiliensis.* This nematode was quite common in *R. rattus,* whereas only 1 fourth-stage larva was collected from *R. exulans* (Table 1). This is in sharp contrast to the prevalence of *O. tenorai,* which was common in both murines. *Nippostrongylus* infects cutaneously (Yokogawa, 1922), while *Orientostrongylus* has been shown to infect orally (Fukumoto, 1979). However, this difference seems to be insufficient to account for the observed difference in the prevalence because the sympatric murines would probably have more or less similar chances of being exposed to the skin-penetrating larvae of *N. brasiliensis* in the fields surveyed. It is therefore suggested that *R. exulans* is less susceptible to *N. brasiliensis.* The susceptibility of *R. exulans* to *N. brasiliensis* should be examined experimentally to see whether or not this is so.

The identification of a capillariin nematode is often difficult, especially when only a small number of incomplete worms are available, as in the present survey. Several capillariins have been recorded from the rats of the Pacific region, but species identification has been made only for *C. traverae* reported from *R. norvegicus* and *R. rattus* of Hawaii and *R. exulans* from Fiji (Ash, 1962; Uchikawa et al., 1984). According to the systematics proposed by Moravec (1982), *C. traverae* may belong to the genus *Baruscapillaria,* not to *Capillaria,* because the latter genus was defined as having a spinose spicular sheath. However, no suitable genus in his system was found to fit for the Capillariinae gen. sp. A. In the absence of a male, it is impossible to decide the genus of the Capillariinae gen. sp. B.

The nematode fauna of the rats in Kao District is depauperate compared to that on Lanyu, a much smaller island of Taiwan, where 17 nematode species have been reported from *R. rattus* (Hasegawa et al., 1994). Some common rat nematodes such as *Calodium hepaticum* (Bancroft, 1893) (=*Capillaria hepatica*), *Eucoleus bacillatus* (Eberth, 1863) (=*Capillaria bacillata*), and *Heterakis spumosa* Schneider, 1866, were not found in the present survey. The rat lung worm, *Parastrongylus cantonensis* (Chen, 1935) (=*Angiostrongylus cantonensis*), which is widely distributed in the Pacific region as well as in Southeast Asian countries (Alicata and Jindrak, 1970), was

not observed either. Moreover, *Globocephalus connorfilii* Lane, 1922, and *Ascarops strongylina* (Rudolphi, 1819), which are common parasites of swines but also parasitize the rats on Lanyu, were not found. However, if more rats were examined, some of these nematodes might be detected. It is also suggested that a limited opportunity for dispersal of rats to the Kao area might be a cause of the reduced nematode fauna.

Acknowledgments

Sincere thanks are rendered to Dr. M. Hasan, director, Kao Health Center for her kind support for this study and to Dr. G. G. Musser, American Museum of Natural History, for his kindness in verifying the identification of rat species. This research was carried out under permission from LIPI, Indonesian Government, and financially supported by a grant-in-aid from the Ministry of Education, Science and Culture, Japanese Government (No. 03041065).

Literature Cited

Alicata, J. E., and K. Jindrak. 1970. Angiostrongylosis in the Pacific and Southeast Asia. Charles C Thomas, Springfield, Illinois. 105 pp.

Ash, L. R. 1962. The helminth parasites of rats in Hawaii and the description of *Capillaria traverae* sp. n. Journal of Parasitology 48:66–68.

Durette-Desset, M. C. 1970. Caractères primitifs de certains Nématodes Héligmosomes parasites de Muridés et de Cricétidés orientaux. Définition d'*Orientostrongylus* n. gen. Annales de Parasitologie Humaine et Comparée 45:829–837.

Fukumoto, S. I. 1979. Life history of *Orientostrongylus ezoensis* Tada, 1975 (Nematoda: Heligmonellidae). Japanese Journal of Parasitology 28:465–471. (In Japanese.)

Hasegawa, H. 1990. Nematodes of the family Heligmonellidae (Trichostrongyloidea) collected from rodents of the Ryukyu Archipelago and Taiwan. Journal of Parasitology 76:470–480.

———, **S. Arai, and S. Shiraishi.** 1993. Nematodes collected from rodents on Uotsuri Island, Okinawa, Japan. Journal of the Helminthological Society of Washington 60:39–47.

———, **J. Kobayashi, and M. Otsuru.** 1994. Helminth parasites collected from *Rattus rattus* on Lanyu, Taiwan. Journal of the Helminthological Society of Washington 61:95–102.

———, **Y. Orido, Y. Sato, and M. Otsuru.** 1988. *Strongyloides venezuelensis* Brumpt, 1934 (Nematoda: Strongyloididae) collected from *Rattus norvegicus* in Naha, Okinawa, Japan. Japanese Journal of Parasitology 37:429–434.

Moravec, F. 1982. Proposal of a new systematic arrangement of nematodes of the family Capillariidae. Folia Parasitologica 29:119–132.

Musser, G. G., and M. D. Carleton. 1993. Family Muridae. Pages 501–755 *in* D. E. Wilson and D. A. M. Reeder, eds. Mammal Species of the World. A Taxonomic and Geographic References, 2nd ed. Smithsonian Institution Press, Washington, D.C., and London.

Ohbayashi, M., and M. Kamiya. 1980. Studies on the parasite fauna of Thailand II. Three nematode species of the genus *Orientostrongylus* Durette-Desset, 1970. Japanese Journal of Veterinary Research 28:7–11.

Ow Yang, C. K., M. C. Durette-Desset, and M. Ohbayashi. 1983. Sur les Nématodes parasites de Rongeurs de Malaisie. II. Les Trichostrongyloidea. Annales de Parasitologie Humaine et Comparée 58:467–492.

Roberts, M. 1991. Origin, dispersal routes, and geographic distribution of *Rattus exulans,* with special reference to New Zealand. Pacific Science 45: 123–130.

Schacher, J. F., and C. H. Cheong. 1960. Nematode parasites of three common house rat species in Malaya, with notes on *Rictularia tani* Hoeppli, 1929. Studies from the Institute of Medical Research, Federation Malaya 29:209–216.

Sinniah, B. 1979. Parasites of some rodents in Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health 10:115–121.

Uchikawa, R., S. Matayoshi, and A. Sato. 1984. Helminth parasites of rats in Fiji and Solomon Islands, with a note of *Capillaria traverae* Ash, 1962. Japanese Journal of Parasitology 33:591–594.

Yokogawa, S. 1992. The development of *Heligmosomum muris* Yokogawa, a nematode from the intestine of the wild rat. Parasitology 14:127–166.